## Part II: GROUNDWATER MANAGEMENT

### *Introduction*

Having supply of fresh water for domestic uses is a fundamental human right. It is a traditional responsibility of local leadership to provide adequate and affordable sources. Accordingly, the maintenance of the infrastructure associated with the supply and the protection of the groundwater source requires coordinated community effort to ensure the ongoing security, viability and sustainability of the watershed. The World Health Organization (WHO) defines reasonable access as "availability of at least 20 liters (5.2 gallons) of water per person per day from a source within one kilometer of the user's dwelling". In assessing whether any individual, family or group of residents have "reasonable access" to water as defined by WHO, the observations in the field seem favorable and most Guiuan residents appear to meet this requirement. Residents who have to carry their water any distance from a well using the standard 5-gallon "jerry can", indicate that they use one to two cans each day for each person in the household.

In Guiuan, where the typhoon has caused the degradation of groundwater and fresh water resources on a broad scale, it is important to promote a groundwater management program that uses a participatory approach involving all in the community. In order to increase awareness about sustainable use of the water resource, this approach requires involvement of the local population, and an objective appraisal of the current situation. Through increased knowledge and understanding of the hydrogeological setting and by leveraging the improvement programs already underway, local leadership will insure continuous improvement through considered and consistent action.

This initial analysis is focused on assisting decision makers, well owners and other community leaders in moving towards a sustainable and improved water supply. The current knowledge at the local level, coupled with the concerted effort to "build back better" with the help of international and national partners, is cause for encouragement and optimism. While fresh water is of primary importance, the education effort should be an immediate imperative to promote protection and sustainable use of all the natural resources and natural assets of Guiuan.

Despite the best efforts of local leadership to effect remedial measures and improvement after the widespread destruction of Typhoon Yolanda, examples of contaminated and neglected wells are still found throughout Guiuan. One of the most glaring illustrations of this is found in a pair of neighboring wells in Baras. In Kabadlungan, a fishing village to the south of the main population center of Baras, there is a new deep well that provides high quality water to the residents. Easily recognizable as a recent Operation Blessing installation, it is appropriately adorned with Biblical verses concerning the vital and spiritual force that water provides. The angelic benefactors were apparently unaware that the devil has set up shop about 10 feet away. The previous well, abandoned for some reason and pump in disrepair, is left unsecured. At the time of the survey, it was found to be collecting garbage. If left to fill up with debris and trash the newly installed well will also be threatened with contamination from the abandoned well (Slides 15 & 16).


Slide 15



Slide 16

***Understanding the Groundwater System***

In many areas of the Guiuan Peninsula the soil is thin or absent and the aquifer makes direct contact with the atmosphere through large interconnected cavities and fractures in the dissolved limestone bedrock. In this case surface runoff and infiltration of any contaminants is rapid. (Fetter 2001).

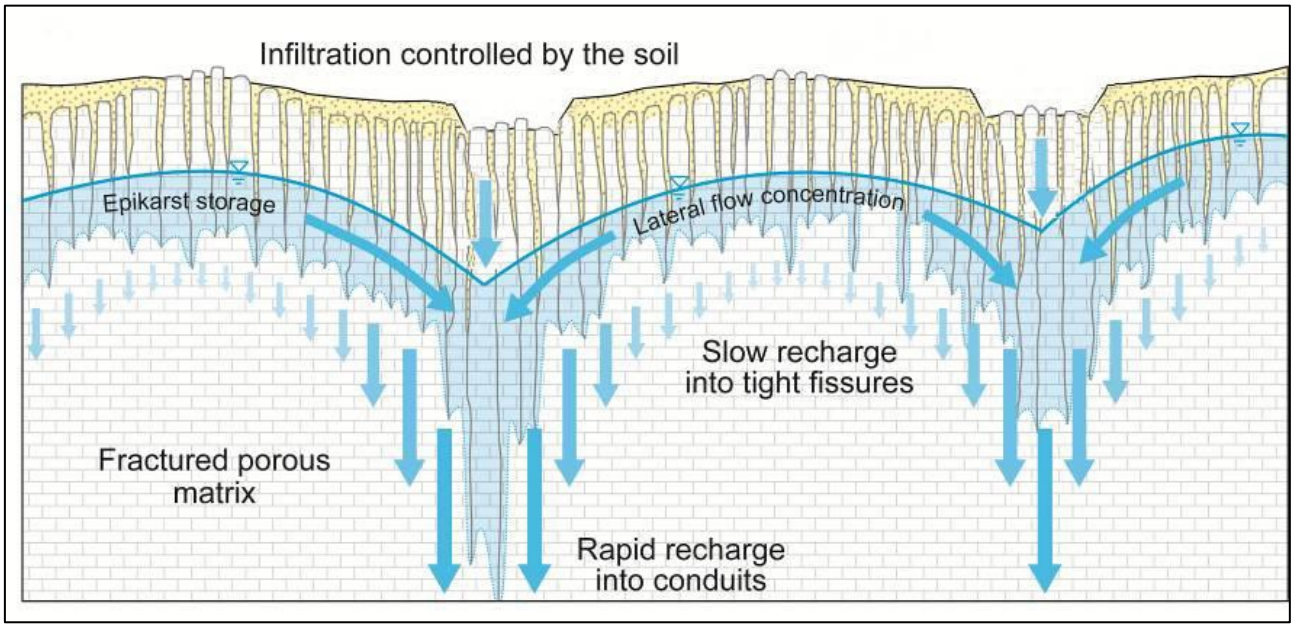


**Figure 13: Model of local waterflows in a karst aquifer. Adapted from Fetter (2001) Applied Hydrology**

Since karst formations control the underlying geology of the region, modeling the ground water flow is not easy using field surveying methods at the surface. A model of the flow is generalized in Figure-13 above. Commonly, models are employed, often using GIS, to compare areas of the landscape and hydrogeologic settings to assess the relative vulnerability to anthropogenic sources of groundwater contamination. Typically, the vulnerability factors considered in such indexes are depth to the water table, the amount of rainfall or recharge of the aquifer, the aquifer media, the soil media, topography, and the hydraulic conductivity. In these models, karst landscapes have the highest vulnerability values. (Aller 1987).

Carbonate Rocks have the most variable hydrogeologic conditions of all major rock types, and groundwater movement in developed karst is highly irregular and complex. Open cavities, shafts and underground caves are much larger than the inter-granular pore spaces through which water moves in sand, gravel and other sediments of other aquifers. Some geologist have even questioned the applicability of the fundamental concept of a water table beneath karst terrains (Bloom 1998). While detailed models may be of limited use, a general understanding of the significance of the karst aquifer and the factors that go into groundwater models is useful. Because it is highly vulnerable and local activity at the surface in any given location has a direct effect on local wells, this basic understanding of how the water behaves in an aquifer and common sense approaches are readily incorporated into local decisions. The location of wells, more often than not, are selected based our best understanding of the underground water system.

In applying this common sense approach, we know that local patches of well-vegetated, isolated and inaccessable karst features or thicker soil will provide protection of the aquifer and increase the quality of specific wells. The further inland a well is located, the less vulnerable it is to salt water intrusion. The separation of septic systems and wells by some distance is also an application of aspects of common sense modeling. Whether it is on top of the ground or underneath, water flows downhill. The thicker the soil, the less vulnerable the aquifer. The higher the recharge (rainfall) the quicker contaminants can reach the aquifer. At the same time, the higher the recharge, the quicker contaminants can be flushed out and neutralized. The nearer the water table is to the surface, the more vulnerable. And so on…. local knowledge and common sense go a long way in decision-making.

There are effects on local water condition due to the high probability of the occurrence of underground passages and caves that traverse the landscape for great distances. Common

knowledge holds that the water that enters a cave in Timala exits at the spring in Poblation Ward 12. While no specific study to prove or disprove the direct connection exists, when we consider a wider model of the underground water system, we know intuitively this phenomenon is true. Common sense and local knowledge validate these common-sense model aspects. Since the dynamic and open nature of the karst aquifer is such an overriding factor, any detailed (and expensive) study to quantify and map specific localized flows underground may be of limited use to inform local decisions. Even on localized scales, the conditions would be constantly evolving with new channels opening up and closing over short time frames. In the common sense approach to the understanding of the groundwater system, the fact that the aquifer is vulnerable to surface water contamination in most highly eroded areas and protected in areas that have a thicker soil covering needs emphasis. Where the karst landscape is highly solutionized and susceptible to swallow hole formation, the potential for contamination from the surface is greater.

In the numerous dolines found throughout the peninsula, where there is sufficient fertile soil to cultivate, agricultural disturbance favors the formation of channels to the aquifer and potential for rapid contamination of the groundwater (Urich 2005). Fortunately, organic farming methods have traditionally been employed in the rural Philippines for centuries and it is encouraging to see these methods now being supported in Guiuan by NGOs assisting with recovery agricultural projects. Widespread contamination of water resources due to the overuse of pesticides and herbicides can be avoided in Guiuan if organic methods of farming remain the rule.

Given the intimate relationship between the surface and water table, the surveyor hesitates to delineate any one area as a recharge zone. The landscape is akin to a sponge or Swiss cheese. However, based on review of the topographical and other digital elevation data

as well as evidence gathered in the field, major areas of recharge are easily identified. On the peninsula, there are two areas that appear as areas of high recharge due to low elevation and thinness or absence of a soil layer. The first is located between the National Road north to Mercedes and the Pacific Ridge. This is roughly the low areas of Bagua, Hagna, and Gahoy and either side of the road connecting these barangays. The second is the area in Cogon especially to the north of the Navy Road. The two areas were identified earlier in this study as possible collapsed caves. The evidence for these recharge areas and associated ground water movement is the ample flow of fresh water along the coastal margins from Alangarog to Bungtod. Other major recharge areas that supply the north western peninsular barangays are found in Mercedes to the north. Conversely the densly packed limestone of the Pacific Ridge is a region of low permiability, that directs water away from east shore of Sapao.

A major lowland feature of Guiuan is an extensive slough area that becomes evident in the swamps below the airstrip in Cantahay and flows mainly through the barangays of Dalaragan, Barbo, and Bungtod. The highly productive aquifer originating in the highlands of the peninsula exits in a slow and widely dispersed flow through this region. This feature is remarkably similar to the Everglades in the state of Florida in the southeastern United States. It is an expansive wetland located at the end of an predominantly karst peninsula landscape. As in Florida, this water combines with the tidal forces to provide a diverse, productive, and valuable estuary dominated by mangroves. In addition to providing a nursery for wildlife, the value of the wetland is in the provision of natural pollution removal services through natural biologic activity. As is now recognized worldwide, natural wetlands are very efficient at neutralizing pollution flowing from point sources such as septic systems as well as treating storm water non-point source pollution (IBRD 2010). Best of all, this essential service is free, courtesy of Mother Nature, and its value and protection should be considered in planning and

land use decisions. The recharge areas and slough feature are identified in the map below in Figure-14.

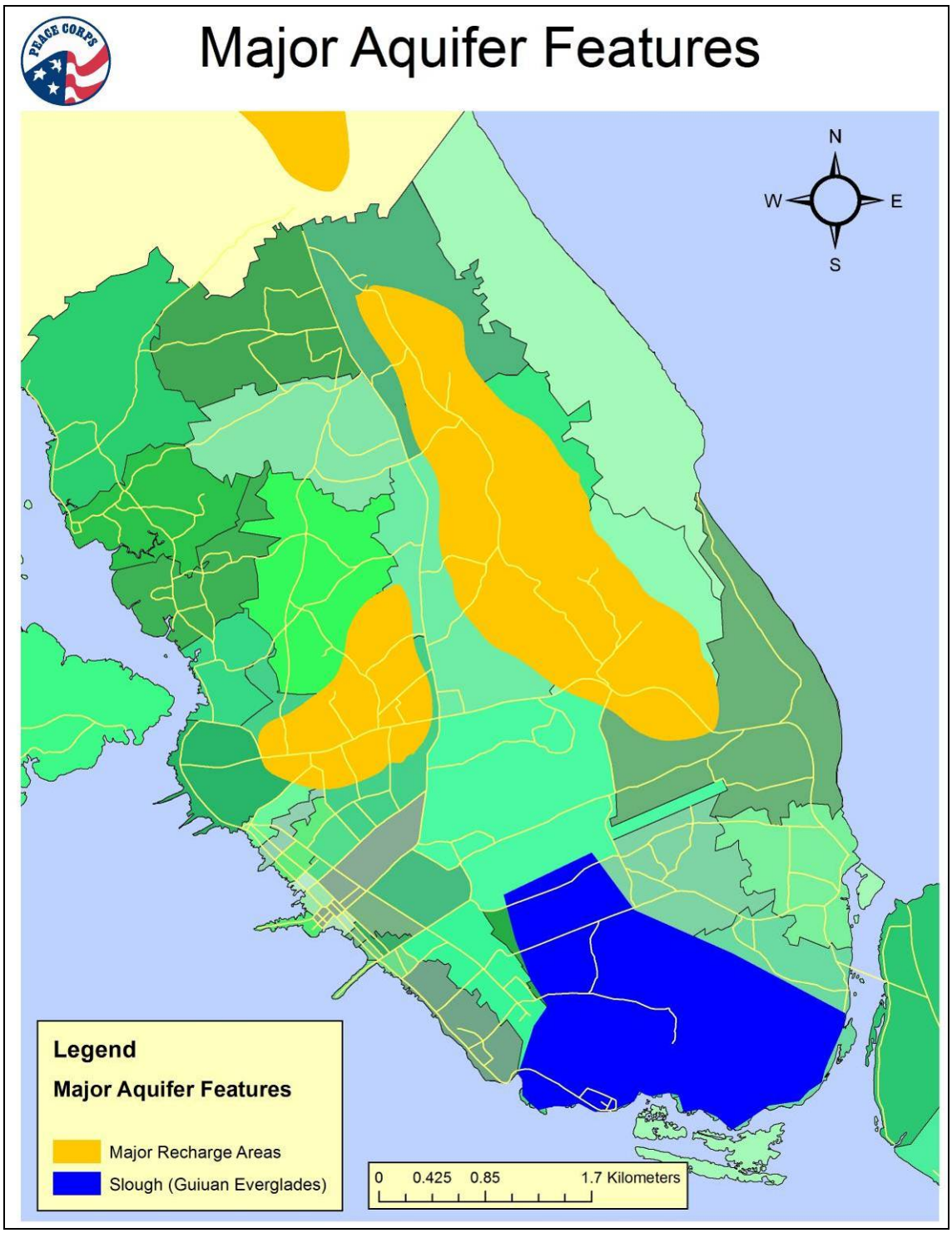


**Figure 14: Major Aquifer Features of the Guiuan Peninsula**

***Saltwater Intrusion***

In many areas near the populated coastal fringes of Guiuan, saltwater intrusion into the freshwater aquifer is increasing. This occurs when water draws are in excess of natural recharge from rainfall, usually as a direct result of human activity. In Guiuan, well water that is normally suitable for utility purposes becomes unacceptable if the salt content becomes high. Under normal or equilibrium conditions and without drawing or pumping, freshwater discharge to the ocean exerts positive pressure that prevents inland migration of saltwater. In areas with large landmass, the denser saltwater forms a wedge under the freshwater. Illustrated in Figure-15, when water is drawn from a well, the interface between the saltwater and freshwater rises (Scholze 2002). Examples applicable in Guiuan, could take the form of excessive pumping at supply wells or the destruction of natural barriers in the construction of channels in the coral shelf areas.

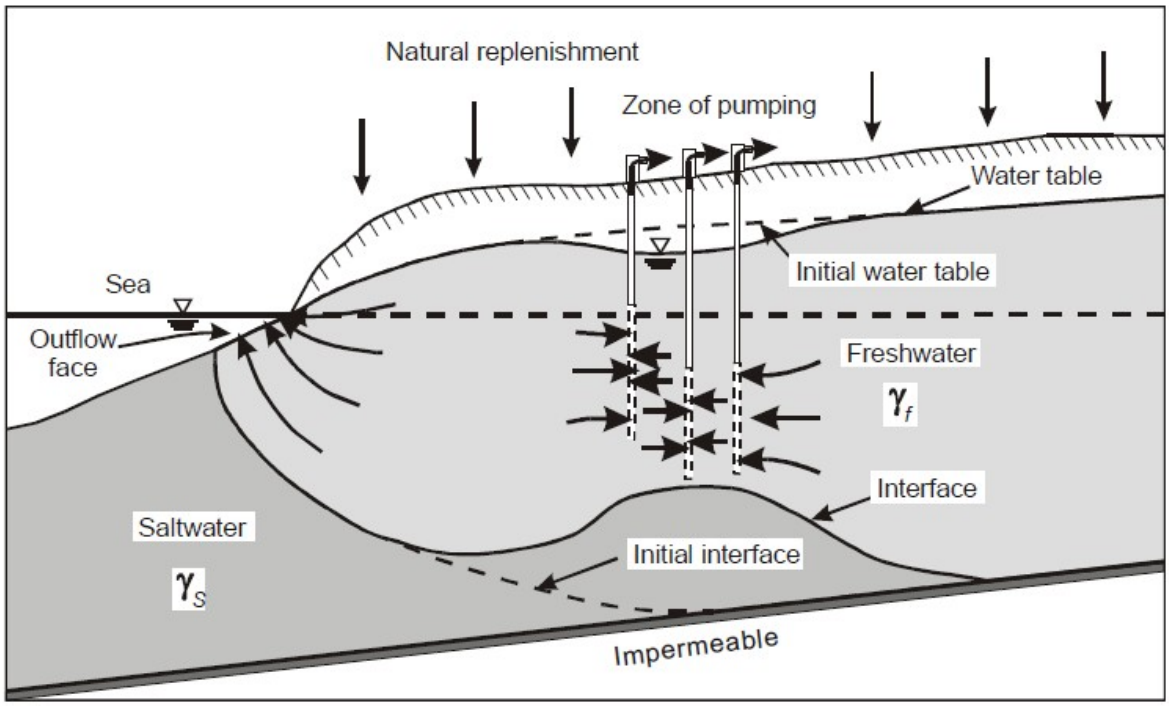


**Figure 15: Adapted from Scholze 2002: Protection of the Groundwater Resources of Metropolis Cebu (Philippines) in Consideration of Saltwater Intrusion into the Coastal Aquifer**

Fresh water flows to the sea at the water's edge and along the submerged coastal margins. The saltwater wedge penetrates into the lower levels of the aquifer. The Guiuan Peninsula is only narrowly connected to Samar Island proper and the underlying strata may behave more as coral reef island than the larger cordilleran islands of the Visayas. In the small coral island case, shown in Figure-16 below, the two wedges meet. The fresh water is fundamentally a "lens" of water of various depths above the saltwater (Dale 1987). This case is highly probable for the Peninsula and almost certainly the case with the narrow island of Caloocan to the south.

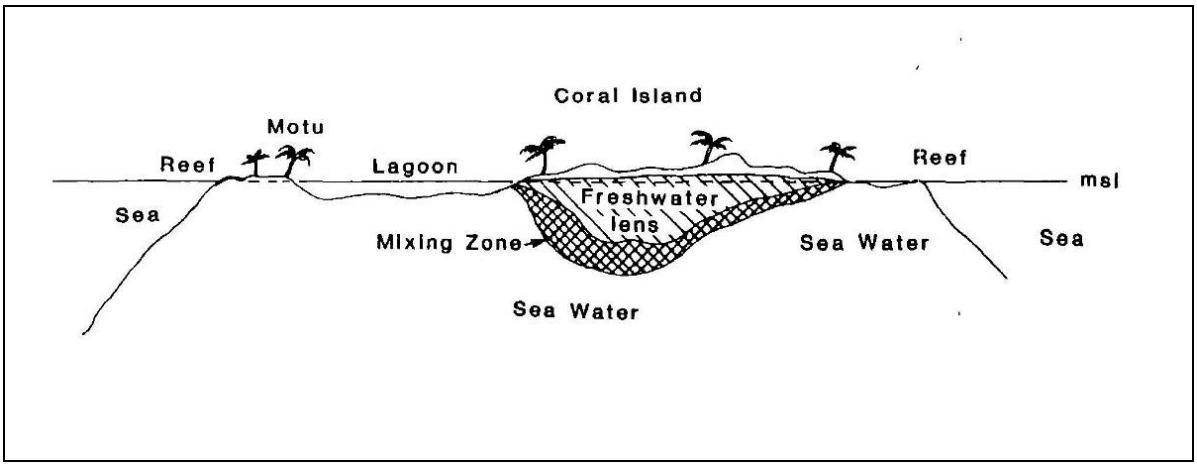


**Figure 16: Island Hydrological Model Adapted from Dale (1987) *Coral Island Hydrology***

Seeps and springs also occur on the coastal areas and along margins of the submerged coral reefs. Found at various depths, some discharge points can be noticed in small openings on the reef, but in general, discharge is too diffused by wave action for specific sources to be identified. However, in shallow areas that are protected and relatively warm and calm, the presence of freshwater in seawater is detected by swimmers and snorkelers who can easily identify them by the distinct change in water temperature and ‘‘blurring’’ of the water due to different densities and light refraction. Cool fresh water on the surface of protected coastal areas is a common occurrence around Guiuan.

Local knowledge throughout the barangays helps us understand the different effects of the salt water on the water table. In Sapao along the narrow strip of land east of the Pacific Ridge, village elders note that during high tides, fresh water at their pump is more abundant than at low tide. With a broad coral fringe protecting the aquifer for some distance out to sea, the high tide raises the freshwater lens and the water table to create the abundance. The wells at the southern tip of Calicoan Island in Sulangan were surveyed at low tide and found to be dry. Local informants told the surveyor that the freshwater would return with the high tide in a few hours as the saltwater raises the water table. In areas of Lupok that lack a broad coastal fringe and have a coastline and adjacent channel that has been extensively engineered and modified by humans over the decades, the influence of high tides increase the salinity of the wells nearest the waterline.

***Sources of Fresh Water***

*Natural and Manually Dug Wells*

In many barangays where the water table is close to the surface, shallow wells supply water for groups of households, allowing them to access water for bathing and other daily washing of other utility purposes. These traditional wells are often found in central locations with well-trodden pathways leading from multiple directions. Occasionally the natural setting and unimproved condition of the well indicates that the freshwater at the surface may be a natural occurrence. Some of these wells have a reputation for safe and good tasting water and have been developed and protected as drinking water wells. These wells have obviously been used for generations and have cultural significance as meeting places in addition to other aesthetic qualities other than simply providing water for daily use. The deepest well surveyed is found in the high elevations in barangay Mayana and is more than 60 feet deep. Local information indicates this well is naturally occuring and is a deep opening that has been improved.

To minimize the influences of the salt water and septic systems, wells in coastal barangays are located as far inland as possible and pump the water some distance to residences located along the coastal roads. In barangays with higher elevations, improved wells seem to be evenly distributed thorough out the neighborhoods to minimize travel distances. A deeper water table means fewer wells and more considered and centralized locations separate from dwellings. In areas nearer the water table, wells seem to be dug with convenience as the main consideration. Consequently, these wells are sited near homes and adjacent to septic systems. In populated areas there is a well for every group of less affluent households and a dedicated well for larger homes with residents of obvious means. A common improvement of the community dug well consists of lengths of culvert piping or masonry "hollow blocks" extending above grade of up to a meter and penetrate the aquifer a distance that allows for sufficient quantities of water to be dipped. Improved wells are often secured with a concrete aprons and removable covers.

Some wells have associated with the water source a manual "Jetmatic" pump (Slide 17). This ubiquitous cast iron, positive displacement pump can be configured remotely away from the water source and plumbed horizontally or can be integrated in a concrete complex directly over the source. Because it uses suction pressure to draw water from the source, Jetmatic pumps are limited to areas where the distance to the water table is less than ten meters (Mihelcic 2009). The Jetmatic allows for flexibility as to the location of the source. Some sources are sealed with concrete covers. Others are simply the dug well with the connecting pipe fitted over rim and into the water below. Many sources are located adjacent to the pump or sealed underground. Jetmatics can be located in common community areas or can be applied inside residences.


The extensive use of ground water from unsecure dug wells in Guiuan poses one of the greatest threats of contamination of the water supply due to damage, improper design or lack of maintenance. These shallow wells are often found to be unlined or lined with open-jointed materials and many do not have proper covers to seal out debris, animals or insects. Some are not curbed and without aprons to prevent the entry of storm water or water from bathing or clothes and dish washing adjacent to the well. When newer more convenient sources of water become available, some wells are abandoned without being sealed and secured and become receptacles for garbage and litter. The importance of common wells as resilient sources of water in times of disruption is widely understood. The widespread destruction of the barangay water systems and the temporary interruption and contamination of the municipal supply system caused by the typhoon, makes the security of these important local resources a priority.

In many locations where the water table exceeds the maximum that can be lifted by a manual suction pump, drilled wells with downhole positive displacement pump applications are used. Locally called "artesian" wells, these pumps have concrete pillars that support long levers and linkages to push the water up from the bottom (Slide 18). They should not be confused with free flowing artesian wells. Many of these pumps are in various states of damage, disrepair and disuse. The remnants in the form of the abandoned pillars and pipe headers can be found throughout the common areas in barangays and along roads. These pumps are designed for maximum leverage of human power to lift the water and require more energy and time to get the water flowing. A common problem expressed with these pumps is the contamination due to rusting linkages and the time and energy it takes for water to run clear.

*Barangay Water System (BWS)* Another source of water is the barangay tank. Supplied by pumped water or gravity-fed captured springs, these systems pipe fresh water to residences nearby. Some are stand-alone systems where residents fill their containers at the well head and tank. Often these systems have faucet stands throughout the denser populated areas of the barangays. Local leaders with their NGO partners have prioritized the recovery of these resources throughout the rural areas, but due to the widespread destruction, the work will take many years to complete. One such new installation in Trinidad, built with Japanese assistance, employs advanced multi-stage filtration. Typically, the capacity of these systems is limited and water flow is restricted to several hours in the early morning until noontime. The supply is unmetered and available on a first-come basis. Some water is supplied at the point of use in homes for a flat monthly fee. A nominal fee is charged to neighbors to fill their containers to provide for the ongoing operation and maintenance of the system.

Commonly referred to as "Solar" tanks, almost every barangay visited had one of these systems that had been decimated by typhoon Yolanda (Slide 19). Representing an extensive water improvement project, these tanks were once configured with solar panels and storage batteries to pump the water to a large elevated tank. The surveyor only found two of these tanks that had been recovered from storm damage. Both tanks are located on Tubabao Island in barangays San Pedro and Camparang. In other barangays, these tanks are otherwise being replaced by various sized plastic or metal tanks on new towers, rehabilitated solar tank towers, or at ground level.


*Municipal Water System (MWS:)* Another source of fresh water is the municipal water supply (Slide 20). The core of the system consists of large concrete tanks with multiple sources with high capacity pumps located at higher elevations on the peninsula. Located in Cantahay, Surok and Timala, one of the tanks is dedicated to supply the barangays situated on Calicoan Island to the south. This metered system also supplies the denser populated areas of Guiuan at lower elevations. Since the typhoon, the MWS has been working at building capacity and improving the quality of the water. The Austrailians helped during the initial stages of recovery testing the water and treating it until it was free of waterborne pathogens.


*Springs and Creeks:* In a few peninsular barangays, where spring flow is plentiful, confining structures are built to effectively separate the fresh water from tidal flows or capture the spring at higher elevations (Slide 21). These springs are often incorporated into the village landscape for recreational, bathing and laundry purposes. In the locations blessed with such a convenient, plentiful, and refreshing resource of fresh water, pools have been established that vary in configuration from natural areas with simple concrete jumping and access platforms to elaborate concrete structures incorporating culverts and retaining walls to channel rainwater around the pool. Some unimproved springs adjacent to tidal areas are only useable during low tides.

The volunteer often used the tidal pool and spring near the Municipal Hall in Ward 12 during lunch to cool off and refresh. Normally, the flow of the spring and the tides cooperate to provide an ample supply of fresh water. However, during periods of low rainfall the fresh water becomes low and "skunky". Even the kids playing hookey from school avoided the spring during these times.


These free community resources are good case studies of how local leadership comes into play. Where strong leadership is present, the spring and creek is free from litter and the user can enjoy a clean and healthful natural environment in which to take care of daily ablutions. Sadly, some sites visited were littered with used packets of shampoo and soap. In one case, a spring user was challenged by the volunteer to provide leadership to clean-up the spring. The resident agreed that it was possible, but informed the volunteer jokingly that he would need monetary compensation. When pressed by the volunteer as to his obligation to his community, the individual agreed, but challenged the volunteer to join in and provide snacks for merienda. The volunteer didn't commit, but speculated that they could clean up the spring for the price of a few soft drinks and other refreshments and have an enjoyable afternoon to boot.

The exploitation of higher elevation springs as a primary water source is more common on the islands of Tubabao, Manicani, Suluan, and Homonhon. These islands, unlike peninsular

Guiuan, having retained much of their clay mantle, flowing water is relatively abundant (Slide 22). Springs and their associated creeks, range from unimproved pools along the stream to sturdy concrete spring boxes or other more permanent stream capture methods that provide improved water quality and access. When these outflows are captured at higher elevations, they are commonly used as the BWS supply with large concrete tanks. Overflow is managed nearby for bathing and laundry purposes.


*Rain Water Collection and Bottled Water:* As might be expected, where households need to haul water some distances to their homes from the source, rainwater catchment in 55-gallon drums and other containers is common sense. Some community sanitary facilities associated with the temporary living quarters of Yolanda affected families or those associated with barangay school rehabilitation, incorporate rainwater catchment extensively in the design.

Another source of water is the local bottled or "mineral" water refiner. These operations found mainly near town are cottage industry, small business in scale and use reverse osmosis and carbon filtering to "purify" the water for drinking. Supplied in 5-gallon containers, prices are such that most of the population is able to use this filtered water. Remarkably, the widespread availability of this water has perhaps unjustly condemned many of the more

traditional sources of water as unfit for human consumption. Without any test data or empirical observations such as the outbreak of water-born bacterial related ailments, most well and pump water is judged "un-safe" for drinking.

***Typhoon Yolanda Considerations***

During the field survey, it was difficult to determine if the current state of the wells was a direct cause of the typhoon or due to natural deterioration and lack of maintenance. Understandably, there is a lot of work in-progress and by all accounts, this was one of the most destructive storms in recorded history. It affected every person in Guiuan and most aspect of their lives in some way. Some typhoon effects are obvious such as the widespread and almost complete destruction of the Barangay Water System utilities. Often referred to as "solar tanks" these used advanced technology to power the water pumps. There is also evidence that the typhoon washed away concrete aprons around wells. The cause of other conditions such as the apparent abandonment of wells and their collection of debris and trash are less apparent. There is evidence that emergency response teams unceremoniously cracked opened wells in the days after the typhoon--wells that were previously covered and secure. Lightweight covers could not withstand the typhoon and were blown away.

The root cause of the condition of the pumps surveyed is also difficult to determine. Jetmatic pumps are of durable construction and would survive many calamities, however many were snapped off by the typhoon debris and falling trees. Others may have been in disrepair and unusable before the storm. From the standpoint of the individual property owner or resident, the repair or installation of a manual Jetmatic pump near their home was a commonly expressed need. The surveyor, however, is not convinced that more Jetmatics is a sustainable solution.

During this survey, it became apparent that manual pumps are convent and desirable but when other priorities or imperatives present themselves, and with a plentiful water supply by the bucket-full just meters away, the pump becomes a luxury and goes unrepaired. Previously protected wells become un-protected and deteriorate because they were not designed for easy and safe access without a pump. Whether breakdown was caused by the typhoon or otherwise, there is evidence that even those who have installed a manual pump in their residences find it difficult to maintain due to a of lack of parts or other resources. Where manual pumps were applied in common community areas, provisions for maintenance are more consistently applied. The surveyor does not consider Jetmatic repair, MWS and BWS supply piping placement, faucet repair and other associated maintenance recommendations in any detail in this analysis.

Exposed, inadequate, and obviously temporary piping for barangay and municipal water systems running along the surface and unprotected would appear to be poor practice when compared to more permanent piping placed underground, however many placements may be temporary measures due to the emergency and other necessities post-typhoon.

***Continuous Improvement***

Water source improvement and development is observed in most locations along the survey trail and every barangay has examples of what could be characterized as "best practice". Examples of innovative designs both traditional and modern are abundant. The following Well Standard is proposed below not to replace any existing program. The surveyor, having some experience in environmental management systems with worldwide application, is suggesting a framework that is successful to achieve continuous improvement. The simple and intuitive approach is applicable at any level of organization and can be applied to improve the water sources in Guiuan.

It is evident throughout the survey trail that barangay leadership is prioritizing specific wells for improvement and newly constructed wells exhibit all the improvements contained in the aspects presented below. Indeed, an important part of any management plan is the dissemination of best and innovative practices and new technologies and in when applied across the board promotes continuous improvement. Apart from new installations, some of the older wells, which have withstood heavy use over the decades, have features that need to be studied. Any improvement program will necessarily take into account available financial, technical resources and other limitations both current and related to the recovery and ongoing resources that can be sustained long term. The improvement plan may apply to one well, a group of wells, or all wells. The program should be administered with the understanding that improvement will occur over many years and is a continuous process. Existing methods of well improvement and existing technologies should be appropriate for the program. Where practical, resources, such as labor and materials should be procured locally.

**A Sample Well Improvement Standard**

This standard is based on the methodology known as Plan-Do-Check-Act (PDCA). PDCA was based on the quality improvement strategies championed by Edward Deming and is generally credited by Japanese industry for their achievements in manufacturing excellence (ASQ 2014). Specifically, the plan is based on components of the ISO-14001 Environmental Management System, used worldwide to achieve improved environmental performance (ANSI 2004).

**Plan:** Formulate a policy; establish the objectives and processes necessary to deliver results in accordance with the policy.

**Do:** Implement the processes.

**Check:** Monitor and measure processes against policy, objectives, targets, and other requirements, and report the results.

**Act:** Take actions to continually improve performance of the management system. Repeat the process starting with a new plan, revised policy, etc. using feedback from the previous cycle.

This plan concerns well improvement but also could be applied to improvements in the Barangay Water Systems and Municipal Water Systems. As with most environmental improvement we make general goals aimed at building a sustainable community, however it is the specific goal setting with tasks, measurable milestones and aspect identification that are essential. In addition, when an improvement plan is implemented, early successes are easy. Gathering the "low hanging fruit" in makes everyone feel confident, however, to have a sustained effort is what management standards are aimed at achieving. Plan-Do-Check-Act recognizes that goals in improvement are "stretch goals" only achievable with continuous effort. This is important because, continuous improvement not only makes things better, but it halts the natural decline in things we build, and systematically sets priorities.

**Sample Guiuan Environmental Standard: Water Source Management**

**1. Scope:**

This Environmental Standard applies to the wells and other groundwater resources used by the population of Guiuan for daily use such as washing and bathing.

**2. Policy**

In order to ensure the safe, secure, sustainable fresh water supply to the barangay residents for domestic use, it shall be the policy of the Barangay leadership to institute and maintain a Well Maintenance and Improvement Program.

**3. Requirements**

Barangay leadership should maintain a comprehensive list of wells in use within the barangay boundaries. A list of water resources and wells should be inclusive. In addition, as new wells are being constructed, they need to be included in the program. The list needs to be documented, reviewed periodically, and kept up to date.

## 4. Assessment and Improvement Plan

A method of classifying and evaluating well security, safety, and sustainability should be developed to be applied across all participating barangays. Minimum standards for wells should be formulated and include, provisions for cover, prevention of surface water to flow into wells, safe access, etc. Barangay leadership should institute a system of periodic inspections to ensure the existing condition of wells is maintained.

**Well Improvement Aspects**

Points

0 -- Well contaminated and abandoned (should be obvious, substantial effort needed to return well to service, otherwise the well should be properly decommissioned and secured)

1 -- Cavity (unimproved)

1 -- Some Wildlife Protection (simple cover netting, etc.)

1 -- Some Runoff Protection from and/or user platforms (simple curbing, coco lumber etc.)

1 -- Improved Shaft (culvert, hollow blocks, concrete, etc.)

1 -- Concrete Apron (should be more than user platform, ideally complete around well)

1 -- Cover (can be simple, heavy duty, may have been adequate but deteriorated)

1 -- Adequate Cover (tight seal, or sealed-not removable)

1 -- Serviceable Cover (Cover tight and Serviceable)

1 -- Secure and Serviceable Cover (Superior designed cover prevents contamination, but can be safely removed and replaced by women, children, and the elderly.

1 -- Pump (manual, electric, etc.)

E--Exempt wells (These are wells, selected by local leadership to be of historical, cultural, and aesthetic significance to deserve preservation in their current state. Improvement can still be applied with appropriate and effective controls and should be designed to ensure preservation of these special wells. This provision should only apply to a few wells.

## 5. Auditing

Barangay leadership should develop a person or persons to assess and audit well conditions. An auditor may be the person conducting well improvement and periodic inspections for their home barangay, however more importantly, Water Resource Auditors will be responsible for providing impartial audits of the wells of sister barangays. The primary duties for the auditor during the audit: 1) to confirm that the requirements of this standard are being implemented, 2) To evaluate and grade the wells, and, 3) Report the results. Audits should be performed annually and documented. To ensure maximum objectivity, Auditors should rotate so they do not audit the same barangay twice in five years. The auditor will report the results of the audit to the Barangay Captain for approval. If there is a dispute, the auditor is to defer to the Barangay Captain's judgment and note the discrepancy in the report.

## 6. Review

The results of the Well Improvement Program should be reported to the Municipal Leadership. The report should include results of the audits, number of wells undergoing improvement, problems in implementation, etc. Municipal leadership should give recognition to barangays with most improvement, best or innovative practice, etc. The municipal leadership will ensure the ongoing suitability and effectiveness of this program.